Comparison of Model Hyetograph Generation and Hydrologic Computation Methods

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Comparison of Methods to Generate Design Hyetographs

Two methods were evaluated for generating design hyetographs for use in the hydrologic modeling:

- 10-year 24-hour L-Moment Design Hyetograph
- SCS Type 2 Distribution

The 10-year 24-hour L-Moment design hyetograph was developed from data presented in a Technical Memo entitled "Updated Precipitation Frequency Results and Synthesis of New IDF Curves for the City of Alexandria, Virginia", prepared for City of Alexandria Transportation & Environmental Services Department (Ref. 1). A variable time interval approach was used to generate the design hyetograph. Therefore, only those values presented in Table 6 (Ref. 1) and Table 8 (Ref. 1) were used. The data used to develop the design hyetograph are presented in Table 1. The design hyetograph data as presented in Table 2, were developed to yield maximum rainfall intensity approximately at the center of the 24-hour storm. Figure 1 compares the 10-year 24-hour L-Moment design hyetograph and SCS Type II distribution hyetograph. Figure 1 shows that L-Moment design hyetograph yields a maximum rainfall intensity of 7.2 inch/hour and SCS Type II distribution hyetograph yields a maximum rainfall intensity of 6.6 inch/hour. The difference is due to the fact that smallest time intervals are 5 and 6 minutes for L-Moment design hyetograph and SCS Type II hyetograph, respectively. Figure 1 also shows a phase lag between the two hyetographs. This is due to using variable time interval approach for L-Moment hyetograph with maximum rainfall intensity centered at 700-minute as evident in Table 2. The 24-hour rainfall total is equal to 4.81 inches for both the hyetographs. Generally, these two hyetographs show very similar rainfall distribution. The L-moment hyetograph generates approximately 36 percent of the 24-hour total rainfall in 30 minutes and 47 percent in 60 minutes. The SCS Type II hyetograph generates 38 percent in 30 minutes and 45 percent in 60 minutes.

TABLE 1
Data for 10-year 24-hour L-Moment Design Hyetograph

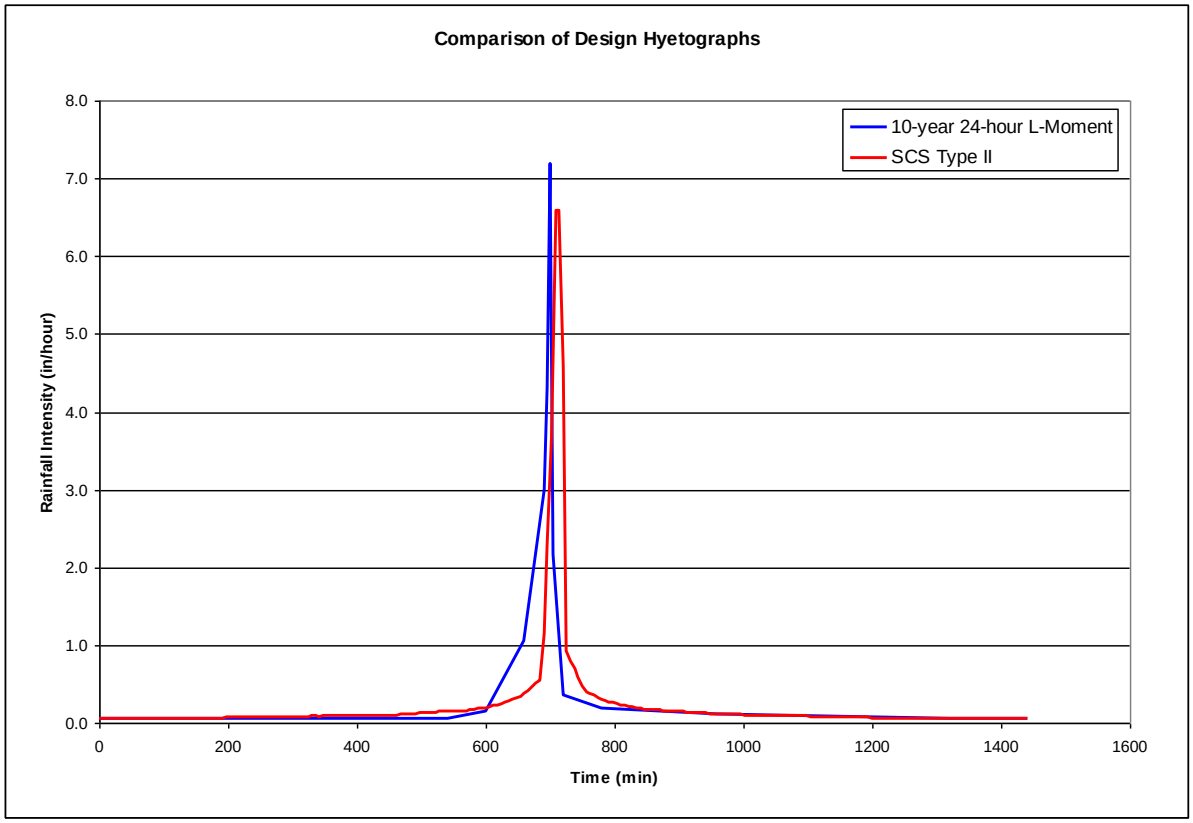
Duration (minutes)	Cumulative Depth (inches)	Source
5	0.600	Table 8, Ref. 1
10	0.960	Table 8, Ref. 1
15	1.210	Table 8, Ref. 1
30	1.750	Table 8, Ref. 1
60	2.280	Table 6, Ref. 1

120	2.640	Table 6, Ref. 1
180	2.800	Table 6, Ref. 1
360	3.360	Table 6, Ref. 1
720	4.050	Table 6, Ref. 1
1440	4.810	Table 6, Ref. 1

TABLE 2
10-year 24-hour L-Moment Design Hyetograph Input Data for XP-SWMM Model

Start Time (minutes)	Duration (minutes)	Absolute Rainfall Depth (inches)	Intensity
0	60	0.0633	0.0633
60	60	0.0633	0.0633
120	60	0.0633	0.0633
180	60	0.0633	0.0633
240	60	0.0633	0.0633
300	60	0.0633	0.0633
360	60	0.0633	0.0633
420	60	0.0633	0.0633
480	60	0.0633	0.0633
540	60	0.0633	0.0633
600	60	0.16	0.1600
660	30	0.53	1.0600
690	5	0.25	3.0000
695	5	0.36	4.3200
700	5	0.6	7.2000
705	15	0.54	2.1600
720	60	0.36	0.3600
780	180	0.56	0.1867
960	360	0.69	0.1150
1320	60	0.0633	0.0633
1380	60	0.0633	0.0633

FIGURE 1
Comparison of Design Hyetographs



Comparison of Runoff Generation Methods

Runoff hydrographs were generated for 10 sub-watersheds located in the Pilot Area of Hooffs Run known as Timber Branch as shown in Figure 2. Two different runoff generation methods and two different design hyetographs were applied as listed below:

Runoff Generation Method:

- EPA-SWMM runoff method
- SCS runoff curve number method

Design Hyetograph:

- The 10-year 24-hour L-Moment design hyetograph
- The 10-year 24-hour SCS Type II design hyetograph

Figure 3 compares the stormwater runoff generated for sub-watershed “007509” in response to SCS Type II design hyetograph using the SCS and SWMM runoff methods. Figure 4 compares the stormwater runoff generated for the same sub-watershed in response to the L-Moment design hyetograph using the SCS and SWMM runoff methods.

These plots are not intended to show that one runoff generation method is better than the other. The two methods use different watershed parameters that are typically calibrated before model predictions are made. The SWMM method uses drainage area, watershed width, basin slope, imperviousness, and infiltration capacity. The SCS method uses drainage area, the curve number CN, time of concentration, and infiltration capacity. In general, for all practical purposes the two methods would produce similar results

with appropriate model calibration. Because flow monitoring data are not available, model calibration is not included in this project.

Recommendations

Given the similarity of the two hyetograph generation approaches, the selection of a method will have limited impact on the modeling results. The L-Moment design hyetograph is recommended for use in the hydrologic modeling because it is based on a more current data set and localized analysis. The SCS Type II hyetograph is based on TP-40 data which has become outdated with the publication of NOAA Atlas 14 in 2004.

Similarly, the runoff generation methods are comparable, within the expected error of the input data. The SWMM runoff method was initially developed for use in ultra-urban areas, therefore this is the recommended approach for runoff generation in the City of Alexandria Storm Sewer Capacity Analysis Project. An additional benefit of this approach is a reduced level of effort associated with compiling the input data. Given the number of drainage areas included in the model, the computation of time of concentrations required for the SCS runoff approach would require a significant effort.

FIGURE 2
Ten sub-watersheds in Pilot Area

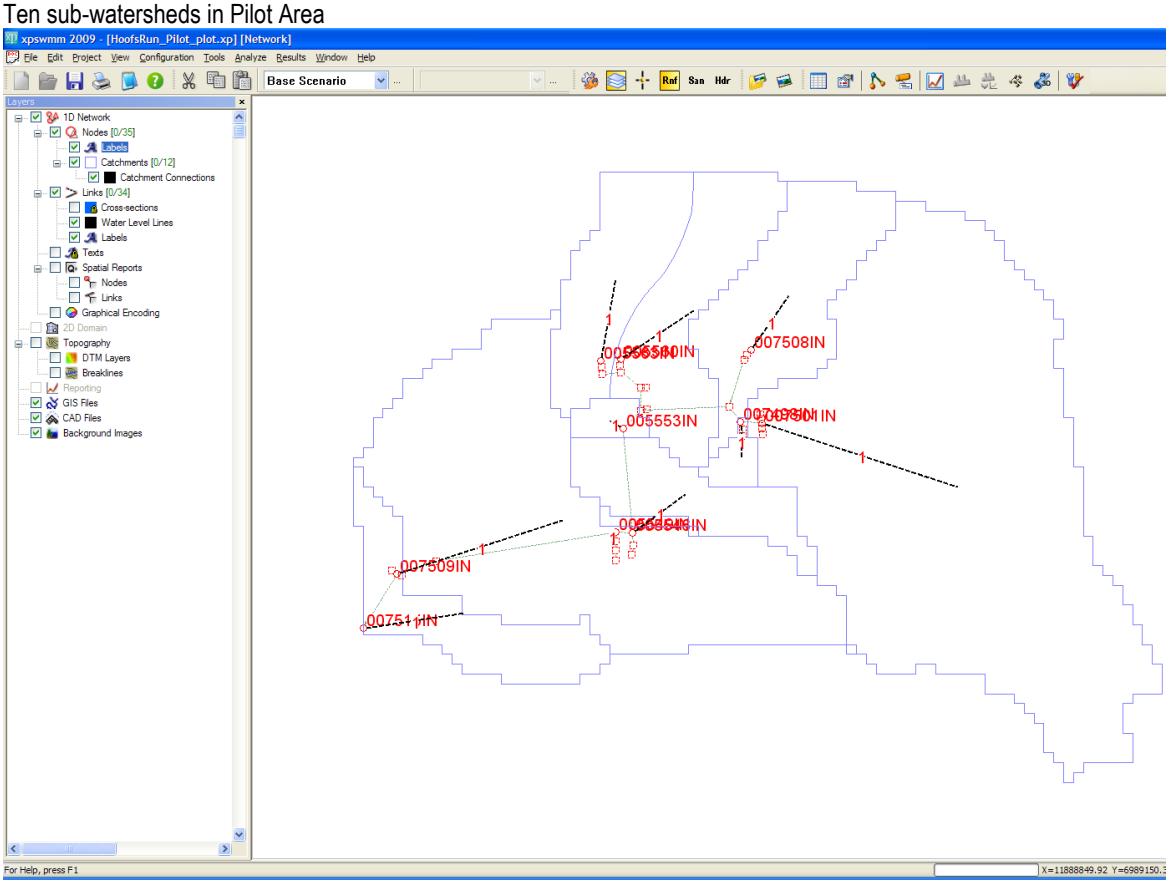


FIGURE 3
Comparison of Different Hydrologic Methods for SCS Type II Hyetograph

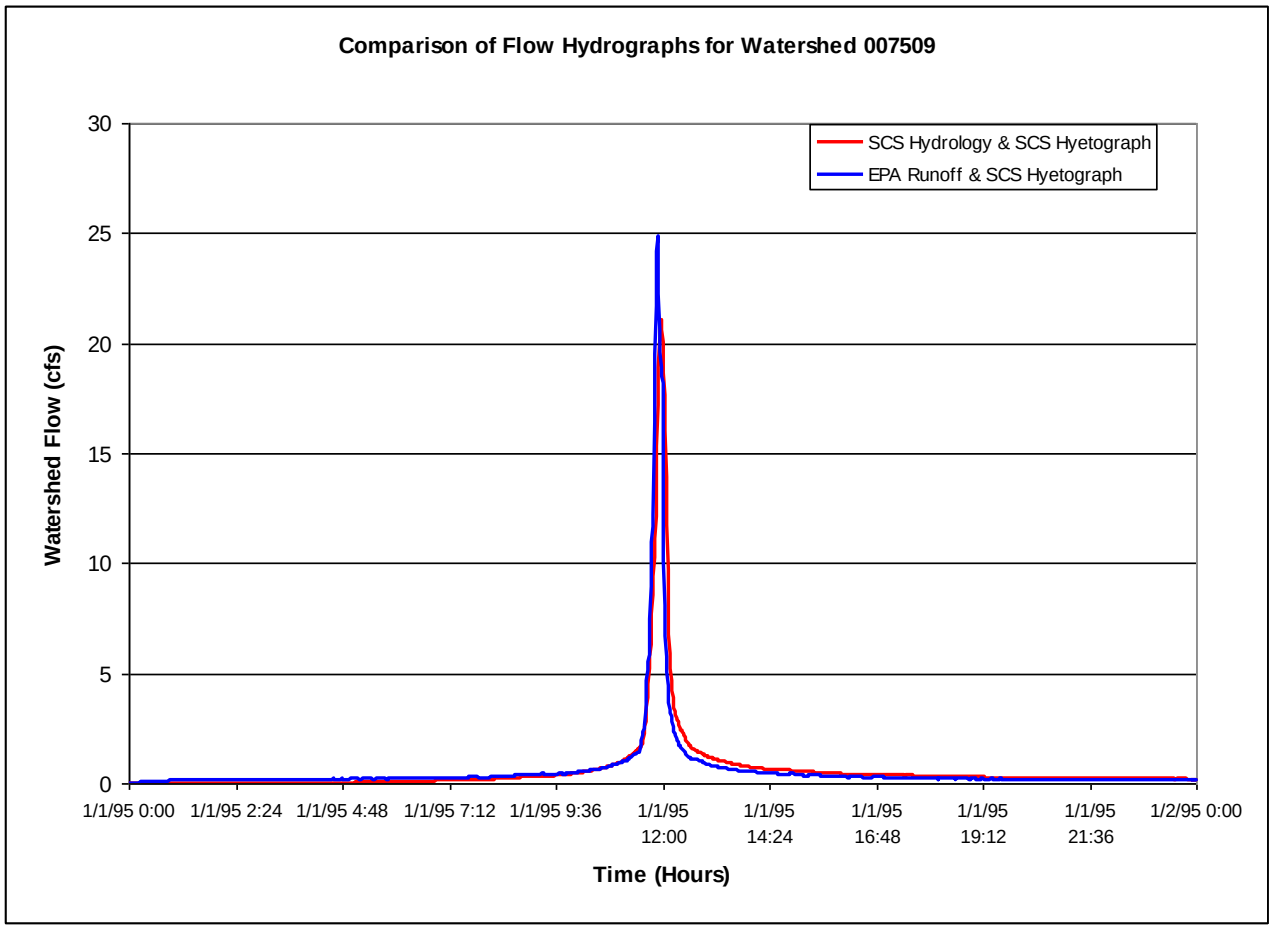
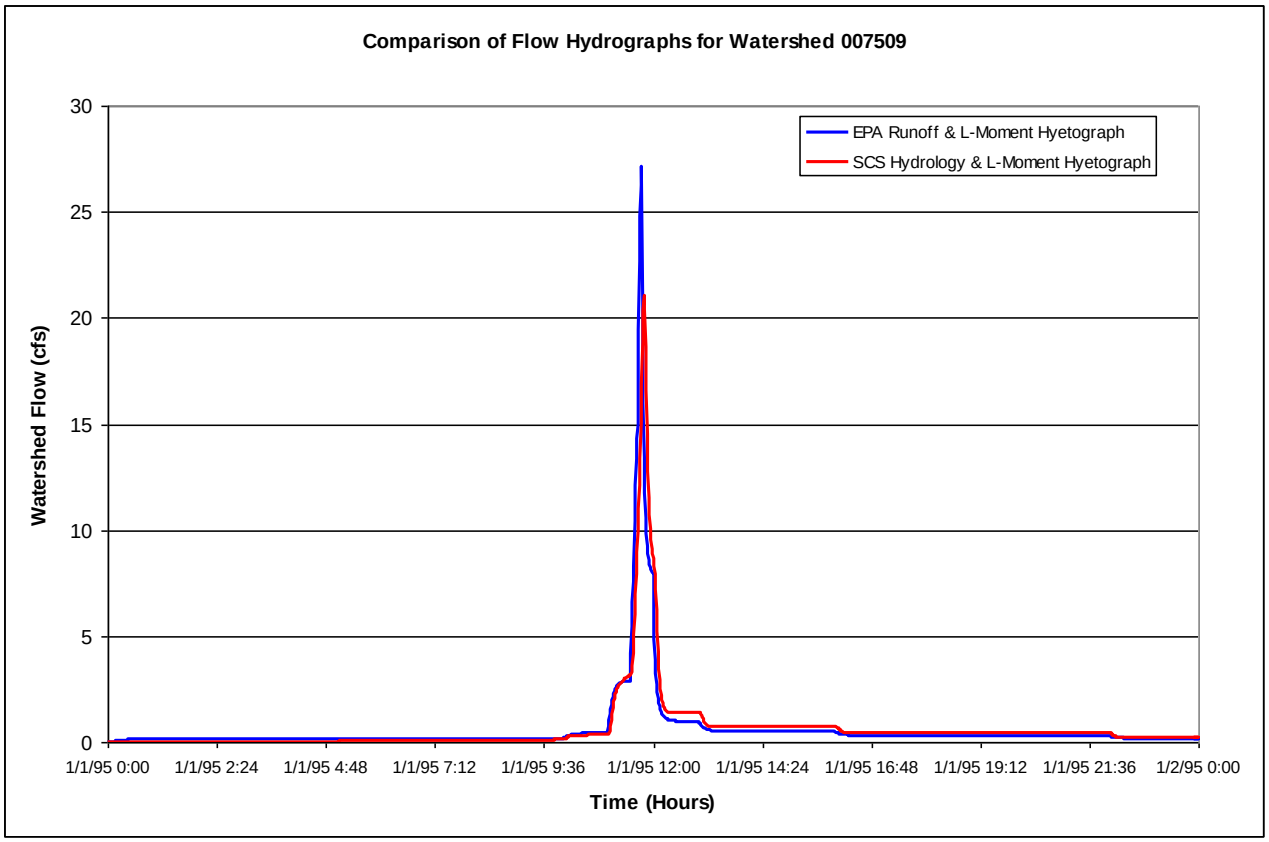


FIGURE 4
Comparison of Different Hydrologic Methods for the L-Moment Hyetograph



References

Updated Precipitation Frequency Results and Synthesis of New IDF Curves for the City of Alexandria, Virginia, prepared for City of Alexandria Transportation & Environmental Services Department, by Wilbert Thomas, Michael Baker, May 1, 2009.